ÖkoRess III

Pilot Screening of Environmental Hazard Potentials of Mine Sites

Factsheet:

Zaldívar

Antofagasta/Barrick Gold, Chile

ID: 68

German Environment Agency

Umwelt Bundesamt

Note

The qualitative assessment of Environmental Hazard Potentials (EHPs) in this factsheet was conducted according to the method developed in the precursor project ÖkoRess I "Discussion of the environmental limits of primary raw material extraction and development of a method for assessing the environmental availability of raw materials to further develop the criticality concept"[1] (Dehoust et al. 2017a). The measurement instructions applied here are described in Dehoust et al. 2017b. The method is tested and further developed within this project (ÖkoRess III).

The information in this factsheet refers exclusively to publicly available, designated sources that have been classified as serious by the authors. It is specifically pointed out that no statement is made about the implementation and quality of agreements or standards that are applied. The implementation of agreements through memberships, certifications, etc. is the responsibility of the companies.

The surface extension of each mine area has been estimated based on publically accessible satellite images as official land-use plans from the public authorities or mine operators are not consistently available. It therefore only corresponds to the apparent area where mining, processing facilities, heaps, etc. and related infrastructure are clearly identifiable.

The fact sheets make no claim to completeness of all relevant voluntary standards. Mentioning a membership in one of the listed voluntary standards does not imply an assessment of the suitability of the standard in itself, nor does it make any statement about the member's success in implementation.

[1]TEXTE 87/2017 https://www.umweltbundesamt.de/publikationen/discussion-of-the-environmental-limits-of-primary

Zaldívar

Copper

General information

Indicator or criteria	Description and values
Name of mine	Zaldívar
Description of mining area	The Zaldívar mine is located in a remote part of the Atacama Desert, about 200 km southeast of the seaport of Antofagasta. It lies within the Andean Precordillera in northern Chile and is part of the western margin of the Atacama plateau. The region around Zaldívar has an arid climate with little precipitation and is characterized by a dry desert landscape. As part of the Domeyko fault system, the Zaldívar porphyry body consists of hypogene mineralization as well as secondary enrichment. In the sulphide zones, pyrite, chalcocite, covellite, chalcopyrite and minor sphalerite and molybdenite occur while brochantite-antlerite, chrysocolla, "black copper", and copper phosphate can be found in the oxide zone (Evans / Lambert 2012 p. 5 ff).
Surface extension	42.04km² 42.04 km² (Image date: 31.3.2019; Viewing height: 14.25 km) (Google Earth)
In operation since	1995 1995 (Antofagasta 2019a)
Operator	Antofagasta
Owner	Antofagasta/Barrick Gold
Closest town	175 km south east of Antofagasta (Antofagasta 2019a)
Province	Antofagasta (Google Maps)
Country	Chile
Longitude	-69.05579°
Latitude	-24.21921°

Altitude	3000 m a.s.l. 3,000 m a.s.l. (Antofagasta 2019a)
Main product and by-products	Main product: copper; by-product: none
On-site processing stages	Crushing, heap-leaching, solvent-extraction and electrowinning (Antofagasta 2019b)
Annual production	47,300 t copper (2018) (Antofagasta 2019c; Consejo Minero 2019) 58,100 t copper (2019) (Barrick Gold 2019)
Proven Reserves	252.8 Mt with an ore grade of 0.46 % copper (Antofagasta 2019b p. 209)
Probable Reserves	214.7 Mt with an ore grade of 0.47 % copper (Antofagasta 2019b p. 209)

Geology

Indicator or criteria	Description and values	Explanation	Assessment result	Data quality
Preconditions for acid mine drainage (AMD)	Copper is a chalcophilic element. Chalcophilic elements are often obtained from sulphidic deposits, which are particularly prone to AMD Dehoust 2017, S. 13). At Zaldivar, copper is mainly mined from oxides (Antofagasta 2019b p. 55) which are not known to be vulnerable for AMD.	The extraction of oxidic minerals has a low environmental hazard potential with regard to AMD.	Low	B1 = medium, can be estimated on the basis of available information
Paragenesis with heavy metals	Copper is a heavy metal itself and often associated with zinc, lead, nickel and arsenic (Dehoust et al. 2017b p. 22). No information about paragenesis with other heavy metals could be found.	Copper is a heavy metal itself. The extraction of copper is consequently always evaluated with a high environmental hazard potential (EHP).	High	B2 = medium, classified according to measurement instructions

Paragenesis with radioactive components	No indication of paragenesis with thorium (Th) and uranium (U) could be found.	In accordance with the measuring instructions, copper ore deposits are evaluated with a medium EHP, if no other information is available.	Low	B2 = medium, classified according to measurement instructions
Deposit size	467.5 Mt ore reserve with an average ore grade of 0.46 % copper (2017) leads to a current deposit size of 2.15 Mt copper (Antofagasta 2019b p. 209).	Calculating with an annual production of roughly 100,000 t of copper, ca. 2.3 Mt of copper were mined at Zaldívar since the mine opening (1995). Together with the current metal content of the reserve, the deposit size is approximately 4.5 Mt. The deposit is classified as large sized and, hence, is evaluated with a high EHP.	High	B2 = medium, classified according to measurement instructions
Ore grade	0.46 % Cu (Antofagasta 2019b p. 209)	With a copper content of 0.46 %, Zaldívar deposit can be assessed as low grade deposit.	Medium	A = high, can be derived directly from available data

Technology

Indicator or criteria	Description and values	Explanation	Evaluation result	Data quality
Mine type	Hard-rock open pit mining (Antofagasta 2019b p. 67)	Conventional solid rock open pit mining is evaluated with a medium EHP. During open pit mining in solid rocks, the mining activities are restricted to the	Medium	A = high, can be derived directly from available data

		horizontal and vertical extension of the ore body/mineralized zone. The impact is higher than in underground mining but less pronounced then in mining of alluvial or unconsolidated sediments.		
Use of auxiliary substances	Truck/Shovel methods are used for mining in Zaldívar. The ore is processed by two dynamic heap leach pads. During this process, the ore is placed on leach pads and treated with a chemical solution, to dissolve the copper from waste rock. Solution from both leach pads is transported to the SX/EW plant for production of copper cathodes. Small amounts of fines are stored in a sediment pond and processed periodically in a small flotation plant (Evans / Lambert 2012 pp. 16–1).	Solvent-extraction is often conducted with the help of toxic additives such as chemical solvents, leading to a high EHP in the evaluation result.	High	A = high, can be derived directly from available data
Mining waste	There are three waste rock facilities and one small tailings storage facility at the mine site of Zaldívar. Tailings from the small flotation circuit are stored in the tailings storage facility in the north of the pit (Evans / Lambert 2012 pp. 16–1).	The disposal of waste in small tailing ponds or dams are evaluated with a medium EHP.	Medium	B2 = medium, classified according to measurement instructions
Remediation measures	Closure plans for all operations of Antofagasta have been approved by the Servicio Nacional de Geología y Minería (Sernageomin). Antofagasta conducts studies and research on aquatic ecosystems in order to determine possible reforestation programmes for native plant species with high biodiversity value in the Tilopozo wetlands (Antofagasta 2018 pp. 85–88)	The EHP is determined as low due to the ongoing recultivation and compensation activities concomitantly to the mining process.	Low	B1 = medium, can be estimated on the basis of available information

Framework conditions natural environment

Indicator or criteria	Description and values	Explanation	Evaluation result	Data quality
Accident hazard due to floods, earthquake, storms, landslides	The rating system for the 4 sub-indicators uses georeferenced data from publicly available risk maps (see measurement instructions Dehoust et al. 2017b). Metrics are directly taken from the given risk assessment. The indicator total is determined by the highest hazard level of the sub-indicators.	The Zaldívar mine has a high EHP for earthquakes which determines the evaluation result. The other sub-indicators have a low EHP.	High	A = high, can be derived directly from available data
Water Stress Index (WSI) und desert areas	The WSI by Pfister et al. (2009) provides characterization factors on the relative water availablility at watershed level. Absolute water shortages in dry areas is supplemented by desert areas. The highest hazard level of the sub-indicators determines the total result.	The EHP for water stress is high and the mine is situated in a desert area. Both results alone already determine the high EHP result.	High	A = high, can be derived directly from available data
Protected areas and AZE sites	Georeferenced data for designated protected areas are used to assess hazards posed by mining extraction. The metric to evaluate EHPs corresponds to the method first described in the draft standard of the Initiative for Responsible Mining Assurance (IRMA 2014).	The mine is not situated in designated protected areas and AZE sites, which results in a low EHP.	Low	A = high, can be derived directly from available data

State Governance

Indicators	
WGI 1 -Voice and Accountability	79.3 °°°
WGI 2 -Political Stability and Absence of Violence/ Terrorism	61 °°°
WGI 3 - Government Effectiveness	77.9 °°°
WGI 4 -Regulatory Quality	88.9 °°°
WGI 5 - Rule of Law	81.7 °°°
WGI 6 -Control of Corruption	82.2 °°°
EPI (Environmental Performance Index)	57.49
EITI membership	Not a member
International Agreements	
ILO 176	No

Others	Ratification of the Minamata Convention on Mercury 27/08/2018 (UNEP 2019) Signature of the Paris Agreement on Climate Change (which entered into force on 12 Mar 2017) (UNFCCC 2016).
Legal framework	
Areas of Law: Environment	The Chilean state is obliged to guarantee a pollution-free environment through environmental legislation. The Environmental Law 19.300 includes the statutory environmental framework and defines that Environmental Impact Assessments (EIA) are mandatory to obtain an environmental license for projects in the mining sector. To these belong, e.g., projects for minerals, oil, gas and coal at different stages of the mine life cycle (exploration to mine closure)(EI SourceBook 2016). The design of the EIAs differ, depending on the potential hazards to a number of social or environmental circumstances. Previous consent of indigenous communities need to be obtained, if these communities are directly affected by a mining project (Minehutte 2019). Three main institutions -with different and defined roles- enforce the environmental regulations: The Ministry of Environment, the Environmental Assessment Service and the Environmental Superintendence. Moreover, according to Law No. 20.600, Environmental Courts have the power to resolve environmental disputes. EIS are presented to the responsible Regional Commission on the Environment or the Executive Directorate of the National Commission on the environment if several regions are affected (ibid.).

Areas of Law: Occupational Health and Safety (OHS)	Chile ratified the ILO Convention N° 161 Occupational Health Services Convention since 1999 (MDNP 2018). The Supreme Decree No. 132/2004 of the Ministry of Mining regulates occupational health and safety (OHS) measures in the mining sector with the objective to protect the life and physical integrity of all humans that work in or are related to the mining industry. It, furthermore, aims to protect facilities and infrastructure that allow mining operations and their continuance (ibid.). In this framework, companies with more than 100 workers are required to have a Risk Prevention Department in place. This department is headed by an expert qualified by the National Geology and Mining Service (SERNAGEOMIN). The development of plans and programs for the prevention of accidents and occupational diseases is mandatory (ibid.). In general, employers are obliged to ensure the safety of employees, machines and buildings (through training, protective clothing, maintenance of machines). At the same time, employees must ensure that occupational safety and safety rules are observed and controlled (ICLG 2018).

Corporate Social Responsibility (CSR)

Voluntary Standards	
Aluminium Stewardship Initiative (ASI): Is the mine owning company a member?	Not applicable Not applicable
Aluminium Stewardship Initiative (ASI): Is the mine certified?	Not applicable Not applicable
International Council of Mining & Metals (ICMM): Is the mine owning company a member?	Yes Yes (ICMM 2019)

Towards Sustainable Mining (TSM) Is the mine owning company a member of the Mining Association of Canada (MAC)?	No No (MAC 2019)
Towards Sustainable Mining (TSM) outside Canada: Are TSM standards implemented*?	No information available No information available
Initiative for Responsible Mining Assurance (IRMA): Is the mine owning company a member?	No No (IRMA 2018)
Initiative for Responsible Mining Assurance (IRMA): Is the mine certified?	No No (IRMA 2018)
Responsible Copper (RC): Is the mine owning company a member of RC?	No information available No information available.
Responsible Copper (RC): Is the mine certified?	No information available No information available.
Responsible Mining Index (RMI): Has the mine been rated?	0.33 / 6.00 0.33 / 6.00 (RMI 2018)
Responsible Mining Index Company indicator „Working conditions“	0.553 0.553/ 1.000 (RMI 2018)
Responsible Mining Index Company indicator „Environmental sustainability“	0.469 0.469/ 1.000 (RMI 2018)
Responsible Steel (RS): Is the mine owner a member of the RS?	Not applicable Not applicable
Responsible Steel (RS): Is the mine certified?	Not applicable Not applicable
Australian Steel Stewardship Forum (ASSF): Is the owner a member of the ASSF?	Not applicable Not applicable
Australian Steel Stewardship Forum: Is the mine certified?	Not applicable Not applicable

ISO and CSR reporting	
ISO 14001 (ISO 14004): Is the mine ISO 14001 certified?	Yes Yes (Evans / Lambert 2012 pp. 20–2)
CSR-directive 2014/95/EU: Does the mine owning company have its headquarters in an EU country?	No No (Great Britain) (RMI 2018)
OECD Guidelines: Does the company have its headquarters in a signatory state?	Yes Yes (Great Britain) (OECD 2019)
ISO 26000: Does the mine implement ISO 26000?*	No information obtained No information obtained
Banking Standards	
WB Standards / IFC Performance Standards: Is the mine financed to a major extend by the world bank?	No information obtained No information obtained
Equator Principles (EP): Is the mine financed to a major extend by a bank adherent to the EP?	No information obtained No information obtained

*by companies own account.

Sources

Antofagasta (2018): Sustainability Report 2017. https://www.antofagasta.co.uk/media/3436/amsa-ingles-5-julio-alta-res.pdf. (02.03.2020).
Antofagasta (2019a): Minera Zaldívar - Historia. http://web.minerazaldivar.cl/quienes-somos/historia/. (02.03.2020).

Antofagasta (2019b): Annual Report and Financial Statements 2018. https://www.antofagasta.co.uk/media/3497/antofagasta-2018-annual-report.pdf (29.07.2019).
Antofagasta (2019c): Zaldívar - Performance 2018. https://www.antofagasta.co.uk/about-us/what-we-do/mining-in-chile/zald%C3%ADvar/. (02.03.2020).
Barrick Gold (2019): Operations - Zaldívar. https://www.barrick.com/English/operations/zaldivar/default.aspx. (10.03.2020).
Consejo Minero (2019): Zaldívar. In: Consejo Minero.
Dehoust, G.; Manhart, A.; Möck, A.; Kießling, L.; Vogt, R.; Kämper, C.; Giegrich, J.; Auberger, A.; Priester, M.; Rechlin, A.; Dolega, P. (2017a): Erörterung ökologischer Grenzen der Primärrohstoffgewinnung und Entwicklung einer Methode zur Bewertung der ökologischen Rohstoffverfügbarkeit zur Weiterentwicklung des Kritikalitätskonzeptes (ökoRess I) - Konzeptband. Umweltbundesamt, Dessau-Roßlau.
Dehoust, G.; Manhart, A.; Möck, A.; Kießling, L.; Vogt, R.; Kämper, C.; Giegrich, J.; Auberger, A.; Priester, M.; Rechlin, A.; Dolega, P. (2017b): Erörterung ökologischer Grenzen der Primärrohstoffgewinnung und Entwicklung einer Methode zur Bewertung der ökologischen Rohstoffverfügbarkeit zur Weiterentwicklung des Kritikalitätskonzeptes (ökoRess I) - Methode für einen standortbezogenen Ansatz. Umweltbundesamt, Dessau-Roßlau.
EI SourceBook (2016): Text of the Law No 19.300 General Bases for the Environment, published on the official gazette on 9th of March 1994. http://www.eisourcebook.org/cms/February%202016/Chile%20General%20Environment%20Law%201994.pdf. (28.12.2018).
EITI (2019): EITI Countries. In: Extractive Industries Transparency Initiative. https://eiti.org/countries. (16.04.2019).
Evans, L.; Lambert, R. J. (2012): Technical Report on the Zaldívar Mine, Rgion II, Chile. Roscoe Postle Associates Inc. http://q4live.s22.clientfiles.s3-website-us-east-1.amazonaws.com/788666289/files/technical-reports/zaldivar-03162012.pdf (02.03.2020).
Eyzaguirre, N. (2018): Chile: Mining Law 2019. In: International Comparative Legal Guides International Business Reports. Text, https://iclg.com/practice-areas/mining-laws-and-regulations/chile. (10.09.2019).
ICMM (2019): Member companies. In: International Council on Mining and Metals (ICMM). https://www.icmm.com/en-gb/members/member-companies. (16.04.2019).
ILO (2017): Ratifications of C176 - Safety and Health in Mines Convention, 1995 (No. 176). In: International Labour Organization (ILO). http://www.ilo.org/dyn/normlex/en/f?p=1000:11300:0::NO:11300:P11300_INSTRUMENT_ID:312321. (12.04.2018).
IRMA (2014): Standard for Responsible Mining. Draft v1.0. Initiative for Responsible Mining Assurance (IRMA). https://responsiblemining.net/wp-content/uploads/2018/09/IRMA_Standard_Draft_v1.007-14.pdf.
IRMA (2018): Responsible Mining Map. In: Initiative for Responsible Mining Assurance (IRMA). https://map.responsiblemining.net/. (16.04.2019).
MAC (2019): Our Members. In: The Mining Association of Canada (MAC). http://mining.ca/members-partners/our-members. (16.04.2019).

MDNP (2018): Country Fiche Chile. In: EU - Latin America Mineral Development Network Platform (MDNP). https://www.mineralplatform.eu/system/files/CountryFiche/MDNP_country-fiche_Chile_02.pdf. (19.09.2019).
Minehutte (2019): Chile - Mining & Environmental Law & Regulations. In: MineHutte - Regulatory Risk Ratings & Analysis of Global Mining Laws. https://minehutte.com/jurisdiction/chile/. (28.12.2018).
OECD (2019): Member Countries. In: Organisation for Economic Co-operation and Development (OECD). https://www.oecd.org/about/members-and-partners/. (05.11.2019).
Pfister, S.; Koehler, A.; Hellweg, S. (2009): Assessing the Environmental Impacts of Freshwater Consumption in LCA. In: Environmental science & technology. Vol. 43, No.11, S. 4098–4104.
RMI (2018): Antofagasta - Company report. In: Responsible Mining Index (RMI). /en/companies/3. (11.09.2019).
UNEP (2019): Minamata Convention on Mercury: Parties and Signatories. In: UN Environment Programme (UNEP) - Minamata Convention on Mercury. http://www.mercuryconvention.org/Countries/Parties/tabid/3428/language/en-US/Default.aspx. (05.11.2019).
UNFCCC (2016): Paris Agreement Signatories Rise to 187. In: United Nations Framework Convention on Climate Change (UNFCCC). https://unfccc.int/news/malawi-armenia-zambia-and-chile-sign-paris-agreement. (23.07.2019).
Wendling, Z. A.; Emerson, J. W.; de Sherbinin, A.; Esty, D. C. (2020): 2020 Environmental Performance Index. Yale Center for Environmental Law & Policy, New Haven, CT. https://epi.yale.edu/epi-results/2020/component/epi (11.08.2020).
WGI (2019): The Worldwide Governance Indicators (WGI). The World Bank. http://info.worldbank.org/governance/WGI/#home. (10.12.2018).

A Glossary

Table 1 Legend

Environmental hazard potential

low

medium

high

Data quality

low

medium

high

- No concrete information, no general specifications of the measurement instructions, expert estimation.
- Assessment not possible due to lack of data at the site, as there is also no evidence for an assessment and there are no generalized assessment rules.

- Assessable on the basis of available information.
- Generalized classification according to measurement instructions.

- Can be derived directly from available data.

B Abbreviations

EHP	Environmental hazard potential
FY	Financial year
kt	Kilo tonnes
m a.s.l.	Meters above sea level
Mt	Million tonnes
OHS	Occupational Health and Safety
t	tonnes
TSF	Tailing Storage Facility
WGI	World Governance Indicators
WHS	Work Health and Safety

C Imprint

Publisher:

German Environment Agency

Section III 2.2

PO Box 14 06

06813 Dessau-Rosslau, Germany

Tel: +49 340-2103-0

info@umweltbundesamt.de

www.umweltbundesamt.de

Contact:

Jan Kosmol – jan.kosmol@uba.de

Contractor:

Projekt-Consult GmbH

Eulenkrugstrasse 82

22359 Hamburg, Germany

T +49 (40) 60306-740

F +49 (40) 60306-199

www.projekt-consult.de

Contact:

Dr. Aissa Rechlin – aissa.rechlin@projekt-consult.de

Christopher Demel – christopher.demel@projekt-consult.de

Project period: 03/2018 –02/2021

The research project has been commissioned by the German Environment Agency as part of the Environmental Research Plan of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) and funded by the Federal Government (FKZ: 3717 35 306 0).

Project Partners:

- ifeu – Institut für Energie-und Umweltforschung Heidelberg gGmbH (Institute for Energy and Environmental Research)
- Öko-Institut e.V. (Institute for Applied Ecology)